

# Heterogeneity of the woody flora of swamp forests in southeastern and southern Brazil

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**Abstract:** Swamp forests are associated with hydromorphic soils and are naturally fragmented in their distribution. Several local phytosociological surveys on the woody flora of these forests have been conducted in southeastern and southern Brazil. We present here a comprehensive floristic list based on these surveys, including 77 families, 211 genera and 518 native species. The richest families were Myrtaceae (78 species), Fabaceae (47) and Lauraceae (38). The richest genera were *Eugenia* (24), *Myrcia* (24), *Miconia* (21) and *Ocotea* (20). The woody flora of these swamp forests has great heterogeneity, with most species occurring in one or few sites. Their flora is formed by a few flooding specialist or tolerant species, common in many sites, and many other species that come from the surrounding vegetation. Considering the high degree of deforestation in southeastern and southern Brazil, including swamp forests, the floristic patterns presented here can be useful for the future efforts of conservation, management and restoration of these forests.

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## INTRODUCTION

Swamp forests is the usual term to describe forested freshwater wetlands on soils saturated or inundated by the water table, although a variety of regional names are used in Brazil (see Dorneles and Waechter 2004). These forests are naturally fragmented, occurring on organic or mineral hydromorphic soils associated with springs, banks of rivers or lakes and natural depressions of the terrain (Ivanauskas *et al.* 1997; Toniato *et al.* 1998; Jacomine 2004; Kurtz *et al.* 2013). They are widely distributed in the Neotropics and interface with different types of vegetation, including forests and grasslands (Teixeira and Assis 2011). Unfortunately, many Brazilian swamp forests have been cleared or impacted by changes in the flooding regime, wood extraction or fire (Ivanauskas *et al.* 1997; Galvão *et al.* 2002; Scarano 2006; Kurtz *et al.* 2013). In some locations (*e.g.*, in the central plateau), they are among the last forest remnants, immersed in an agricultural matrix.

In Brazil, the quantitative surveys of the woody layer of swamp forests are virtually restricted to the southeastern and southern regions (Table 1; see also Teixeira and Assis 2011), where some phytogeographic comparisons have been done. These forests have very low floristic similarity with river-flooded forests (Rodrigues and Nave 2004; Silva *et al.* 2007; Kurtz *et al.* 2013) or among each other (Teixeira and Assis 2011; Magalhães and Maimoni-Rodella 2012; Guilherme *et al.* 2013). We argued in a recent study (B.C. Kurtz and F.R. Scarano, unpublished data) that the great floristic heterogeneity of swamp forests of southeastern

and southern Brazil is related to variation in the ecological conditions, *i.e.*, geographical position, climate, topography, flooding regime, water quality, successional stage, neighboring vegetation types, and also history of human disturbance. So, we concluded that swamp forests of southeastern and southern Brazil cannot be considered a distinguishable floristic unit.

Although the overall structural and floristic patterns of these forests have been recognized, *i.e.*, low diversity, concentration of individuals in one or a few flooding specialist or tolerant species, and flora strongly influenced by the surrounding vegetation (*e.g.*, Teixeira and Assis 2011; Kurtz *et al.* 2013), there is so far no comprehensive floristic list on a regional scale, showing the occurrence of species in different sites. Thus, we present here the list of the woody flora of swamp forests of southeastern and southern Brazil, including surveys conducted in the coastal plain and the central plateau, and analyze the floristic profile of this vegetation type. This list can be a useful tool for the future efforts of conservation, management and restoration of swamp forests.

## MATERIALS AND METHODS

### *Study Sites and Data Collection*

We included in the analysis 28 phytosociological studies conducted in swamp forests of southeastern and southern Brazil, adding up 37 sites surveyed: 24 sites are located in the coastal plain between the states of Rio de Janeiro and Rio Grande do Sul, and 13 sites are located in the central plateau, including the Distrito Federal and the states of São Paulo and Minas Gerais

**TABLE 1.** Phytosociological surveys of the woody layer of swamp forests from southeastern and southern Brazil. Site: RJ: Rio de Janeiro; SP: São Paulo; PR: Paraná; RS: Rio Grande do Sul; MG: Minas Gerais; DF: Distrito Federal; Alt.: approximate altitude (meters above sea level); Cli.: climate according to Köppen classification; DBH: diameter at breast height, used as an inclusion criterion; A/P: sample area (ha)/number of points; N: number of live individuals surveyed; S: number of species; I: identified native species; H': Shannon diversity index (nat. ind.<sup>-1</sup>); and J': Pielou evenness index.

SITE	CODE	ALT.	CLI.	DBH	A/P	N	S	I	H'	J'	REFERENCE
Coastal plain											
Restinga de Jurubatiba National Park, RJ	JU1	< 12	Aw	≥ 5 cm	1.44	2164	84	81	3.42	0.77	Kurtz <i>et al.</i> (2013)
Restinga de Jurubatiba National Park, RJ	JU2	< 12	Aw	≥ 5 cm	0.5	938	45	37	2.79	0.73	Oliveira (2000)
Restinga de Jurubatiba National Park, RJ	JU3	< 12	Aw	≥ 5 cm	0.52	827	49	39	2.76	0.71	Barros (2000)
Poço das Antas Biological Reserve, RJ	PA1	10	Aw	≥ 10 cm; height ≥ 10 m	1	486	97	81	3.98	0.87	Guedes-Bruni <i>et al.</i> (2006)
Poço das Antas Biological Reserve, RJ	PA2	10	Aw	≥ 10 cm	0.72	628	31	29	1.75* 1.99*	0.57* 0.66*	Carvalho <i>et al.</i> (2006)
Poço das Antas Biological Reserve, RJ	PA3	10	Aw	≥ 3.5 cm	0.5	1744	59	23	1.30	-	Scarano (2006)
Ilha Anchieta State Park (site F), SP	IAN	4	Af	≥ 1.6 cm	?	363	38	37	3.13	0.84	Reis-Duarte (2004)
Bertioga, SP	BER	10	Af	≥ 3.2 cm	0.24	476	65	58	3.50	0.84	Guedes <i>et al.</i> (2006)
Campina do Encantado State Park (shallow peat forest), SP	CE1	< 15	Cfa	≥ 4.8 cm	0.3	519	46	45	2.98	0.78	Sztutman and Rodrigues (2002)
Campina do Encantado State Park (deep peat forest), SP	CE2	< 15	Cfa	≥ 4.8 cm	0.2	546	5	5	0.82	0.51	Sztutman and Rodrigues (2002)
Ilha do Cardoso, Cananéia (site II), SP	ICA	< 14	Af	≥ 1.6 cm	0.1	867	30	30	2.44	0.71	Sugiyama (1998)
Ilha do Mel, Paranaguá, PR	IM1	< 5	Af	≥ 5 cm	0.56	1510	53	50	3.22	0.81	Silva <i>et al.</i> (1994)
Ilha do Mel Ecological Station (periodically flooded swamp), PR	IM2	< 5	Af	≥ 4.8 cm	0.3	500	54	52	3.22	0.81	Menezes-Silva (1998)
Ilha do Mel Ecological Station (permanently flooded swamp), PR	IM3	< 5	Af	≥ 4.8 cm	0.4	607	60	55	3.21	0.78	Menezes-Silva (1998)
Passa-Sete, Morretes, PR	PST	10	Af	≥ 10 cm	0.26	419	13	12	-	-	Galvão <i>et al.</i> (2002)
Batuva, Guaraqueçaba, PR	BAT	70	Af	≥ 10 cm	0.16	312	13	12	-	-	Galvão <i>et al.</i> (2002)
Cabaraquara, Matinhos, PR	CAB	2–3	Af	≥ 10 cm	0.32	443	27	23	-	-	Galvão <i>et al.</i> (2002)
Atami, Pontal do Paraná, PR	ATA	3	Af	≥ 10 cm	0.2	410	29	19	-	-	Galvão <i>et al.</i> (2002)
Alexandra-Matinhos, Matinhos, PR	ALE	5	Af	≥ 10 cm	0.2	337	36	29	-	-	Galvão <i>et al.</i> (2002)
Guaratuba 1, Guaratuba, PR	GT1	5	Af	≥ 10 cm	0.3	400	26	22	-	-	Galvão <i>et al.</i> (2002)
Guaratuba 2, Guaratuba, PR	GT2	5	Af	≥ 10 cm	0.4	434	78	59	-	-	Galvão <i>et al.</i> (2002)
Torres, RS	TOR	< 20	Cfa	≥ 2.5 cm	0.2	706	60	50	-	-	Kindel (2002)
Lagoa do Peixe National Park, RS	LPE	< 15	Cfa	≥ 5 cm	60	240	21	21	2.60	0.85	Dorneles and Waechter (2004)
Taim, RS	TAI	< 10	Cfa	≥ 10 cm	30	120	12	19**	1.89	0.76	Waechter and Jarenkow (1998)
Central plateau											
Uberlândia, MG	UBE	860	Aw	≥ 4.8 cm	0.62	2189	33	29	2.27	0.65	Nogueira and Schiavini (2003)
Coqueiral, MG	COQ	810–840	Cwb	≥ 5 cm	0.32	585	99	99	3.50	0.76	Rocha <i>et al.</i> (2005)
Santa Rita de Caldas, MG	SRC	1158–1204	Cfb	≥ 5 cm	1	2982	110	107	2.98	0.63	Loures <i>et al.</i> (2007)
Cristais Paulista, SP	CRP	945–1000	Cwb	≥ 3.2 cm	0.6	2036	61	82**	2.71	0.66	Teixeira and Assis (2009)
Campinas, SP	CA1	590–610	Cwa	≥ 3.2 cm	0.2	904	55	49	2.80	0.70	Toniato <i>et al.</i> (1998)
Campinas Experimental Centre, SP	CA2	660	Cwa	≥ 5 cm	0.87	930	33	21	2.45	0.70	Torres <i>et al.</i> (1994)
Brotas, SP	BR1	620–680	Cwa	≥ 5 cm	0.36	735	51	40	2.81	0.71	Marques <i>et al.</i> (2003)
Brotas, SP	BR2	710–740	Cwa	≥ 4.8 cm	0.2	498	33	26	2.52	0.72	Costa <i>et al.</i> (1997)
Itatinga, SP	ITA	570	Cwa	≥ 4.8 cm	1	1242	39	35	2.75	0.75	Ivanauskas <i>et al.</i> (1997)
Agudos, SP	AGU	550	Cwa	≥ 4.8 cm	0.22	989	34	32	2.60	0.74	Paschoal and Cavassan (1999)
Rio Claro, SP	RCL	630–650	Cwa	≥ 4.8 cm	0.45	1651	49	43	2.10	0.54	Teixeira and Assis (2005)
Brasília National Park, DF	BRA	990–1040	Aw	≥ 3 cm	0.8	2763	60	45	2.99	0.73	Guarino and Walter (2005)
Sucupira farm, DF	SUC	1100–1200	Aw	≥ 3 cm	0.8	2667	53	44	2.84	0.71	Guarino and Walter (2005)

\* Values of H' and J' for the two fragments surveyed  
\*\* Number of species in the floristic survey

(Table 1 and Figure 1). These were the same sites used in our previous phytogeographic study (B.C. Kurtz and F.R. Scarano, unpublished data). The sampling effort (number of individuals surveyed) was different between surveys, depending on the inclusion criteria and sample size (Table 1).

### Data Analysis

The names of all species present in those surveys were reviewed according to *Lista de Espécies da Flora do Brasil* (2014), or by specialists. Species not identified at this level or doubtful names were excluded from the floristic list. The vouchers are cited in the surveys presented in Table 1.

## RESULTS

In the 37 sites it was identified a total of 77 families, 211 genera and 518 native species of trees and shrubs: six ferns, two gymnosperms and 510 angiosperms. Four exotic species were additionally identified, which were included in the floristic list (Appendix 1), but excluded from the calculations below.

The ten richest families were: Myrtaceae (78 species), Fabaceae (47), Lauraceae (38), Melastomataceae (29), Rubiaceae (23), Euphorbiaceae (17), Moraceae (17), Annonaceae (15), Primulaceae (15) and Meliaceae (14). These families (13% of the total) accounted for more than half (56.6%) of the species identified. Twenty-two families (28.6%) had only one species. The genera with the largest number of species were: *Eugenia* (24), *Myrcia* (24), *Miconia* (21), *Ocotea* (20), *Ficus* (12), *Myrsine* (11), *Inga* (9), *Machaerium* (9), *Calyptanthus*, *Ilex*, *Marlierea*, *Nectandra* and *Trichilia* (8 species each).

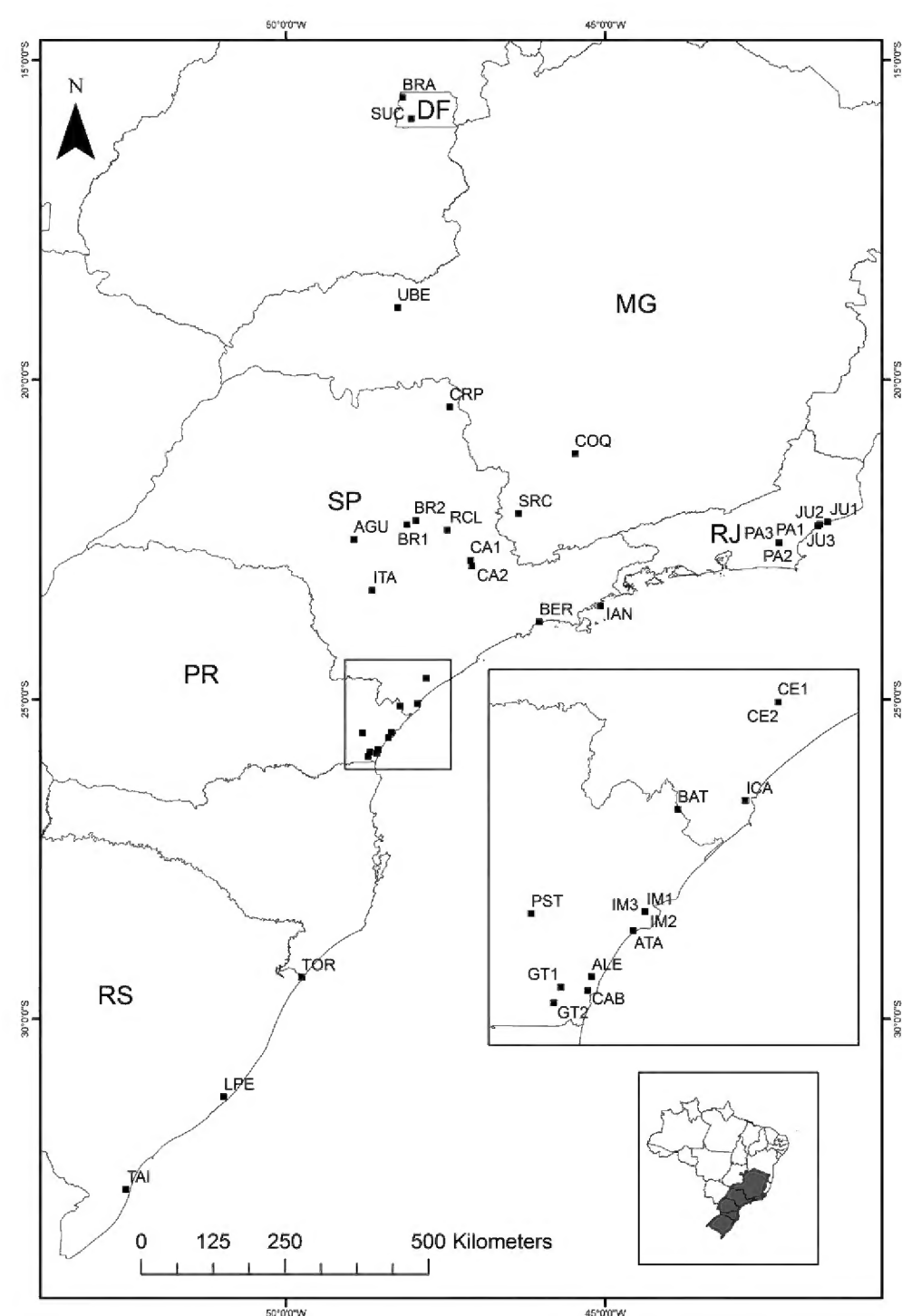
Two hundred sixty-eight species (51.7%) were sampled in only one site, and 349 (67.4%) in up to two sites. On the other hand, only six species (1.2%) were sampled in more than half of the sites (Appendix 1): *Calophyllum brasiliense* Cambess. (30), *Tapirira guianensis* Aubl. (25), *Pera glabrata* (Schott) Poepp. ex Baill. (23), *Alchornea triplinervia* (Spreng.) Müll. Arg. (20), *Euterpe edulis* Mart. (19) and *Tabebuia cassinoides* (Lam.) DC. (19).

In the swamp forests of the coastal plain, a total of 304 species were sampled, and to those located in the central plateau, a total of 313 species. Only 99 species (19.1%) were common to both sets of swamps.

## DISCUSSION

Swamp forests of southeastern and southern Brazil usually show low richness, diversity and evenness, which are often associated with the intense selective character of oxygen deprivation caused by soil waterlogging (e.g., Scarano 2006). However, there is some degree of site-level variation in these parameters (Table 1), which is related to local and regional variation in the ecological conditions mentioned above.

Most of the families and genera with highest number of species, cited before, are among the richest taxa in the tree flora of the Atlantic Forest *sensu lato* (rain and semi-deciduous forests) and the Cerrado (Brazilian savannas; Oliveira-Filho and Fontes 2000), where the swamp forests analyzed here are—or at least were before the intense fragmentation process that these vegetation formations



**FIGURE 1.** Map of southeastern and southern Brazil, showing the location of the 37 swamp forest sites used to prepare the floristic list. DF: Distrito Federal; MG: Minas Gerais; SP: São Paulo; RJ: Rio de Janeiro; PR: Paraná; RS: Rio Grande do Sul (see Table 1 for details and references).

undergone—inserted.

The influence of the neighboring vegetation types on the woody flora of swamp forests of southeastern and southern Brazil has often been highlighted in the literature (e.g., Teixeira and Assis 2011; Kurtz *et al.* 2013). Throughout the ecological successional process, which is controlled by the phreatic flooding regime, the migration and establishment of neighboring species are progressively stronger (Kurtz *et al.* 2013). This influence was responsible for the floristic differentiation between swamp forests of the coastal plain and the central plateau, and also for the great heterogeneity of their flora (B.C. Kurtz and F.R. Scarano, unpublished data), with most of the species occurring in one or a few surveys. On the other hand, only a few flooding specialists (e.g., *Calophyllum brasiliense*, *Tabebuia cassinoides*, *Protium spruceanum* (Benth.) Engl. and *Magnolia ovata* (A. St.-Hil.) Spreng.) or generalists (especially *Tapirira guianensis*) are frequent, although they may be restricted or concentrated in the coastal plain or central plateau (Appendix 1). In general, these species stand out in the structure of swamp forests—monodominance or oligarchy are often found—and are accompanied by a variable number of species from the surroundings (see references in Table 1). The latter usually have low density and importance in phytosociological surveys, but promote richness and diversity on local and regional



scale (Teixeira and Assis 2011). However, it is evident that the potential immigration of species from the surroundings is reduced in many swamp forests that are immersed in a matrix of agricultural or disturbed areas.

According to the Brazilian environmental legislation, swamp forests are situated in 'Areas of Permanent Preservation' and their suppression could only occur in special cases. Unfortunately, this has not always been enforced, which led to the destruction of a large portion of these forests in Brazil. Swamp forests are a very fragile vegetation (Scarano *et al.* 1998; Jacomine 2004; Kurtz *et al.* 2013), and particularly sensitive to changes in the flooding regime. When these changes occur due to human activity and become permanent, in addition to rapid degradation, the forests show no natural recovery (Scarano *et al.* 1998). The rectification of river channels, the construction of embankments and the installation of drainage systems have been responsible for the virtual disappearance of the swamps on the coastal plains of Rio de Janeiro (Kurtz *et al.* 2013). Facing this fragility, the first step to the conservation or restoration of these forests is the maintenance or reestablishment of the original flooding regime, respectively.

The patterns and aspects discussed above are important to guide the future efforts of conservation and management of swamp forest remnants in southeastern and southern Brazil and the restoration of disturbed areas. In restoration projects that involve tree reintroduction (*e.g.*, Zamith and Scarano 2010), the set of species to be used will vary considerably from area to area, depending on the local ecological conditions already mentioned. In this regard, the list presented here, which included almost all surveys conducted in southeastern and southern Brazil, is an important tool helping the correct choice of these species. The community structure of each site, as shown by phytosociological studies (see references in Table 1), will assist in determining the proportion of their seedlings. Obviously, a project to restore a flood-prone forest depends on many other variables to the definition of a model to be used (*e.g.*, Kageyama and Gandara 2004; Zamith and Scarano 2010). Following the general recommendation to flood-prone forests (Rodrigues and Nave 2004), the projects in swamp forests should include species with widespread distribution in these formations (flooding specialists and some generalists) and species typical of the region under recovery, which often are common in the surrounding vegetation(s).

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APPENDIX 1. List of the woody flora of swamp forests of southeastern and southern Brazil, based on 37 local surveys (see Table 1 for details and references).

FAMILIES/SPECIES/SITES	COASTAL PLAIN														CENTRAL PLATEAU																							
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC	
ANACARDIACEAE																																						
<i>Lithrea molleoides</i> (Vell.) Engl.																										X												
<i>Schinus terebinthifolius</i> Raddi																										X												
<i>Tapirira guianensis</i> Aubl.	X	X	X	X	X	X	X	X	X			X	X	X				X	X	X	X			X	X			X	X	X	X	X	X	X	X	X	X	
<i>Tapirira obtusa</i> (Benth.) J.D. Mitch.																								X	X	X	X	X										
ANNONACEAE																																						
<i>Annona acutiflora</i> Mart.	X																																					
<i>Annona cacans</i> Warm.																														X								
<i>Annona dolabripetala</i> Raddi				X																						X												
<i>Annona emarginata</i> (Schltdl.) H. Rainer																					X					X												
<i>Annona glabra</i> L.	X																																					
<i>Annona neosericea</i> H. Rainer																									X													
<i>Duguetia furfuracea</i> (A. St.-Hil.) Saff.																																				X		
<i>Duguetia lanceolata</i> A. St.-Hil.																																						
<i>Guatteria australis</i> A. St.-Hil.							X	X					X																							X		
<i>Xylopia aromatica</i> (Lam.) Mart.																																					X	
<i>Xylopia brasiliensis</i> Spreng.				X																																	X	







APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN														CENTRAL PLATEAU																							
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC	
<i>Syagrus romanzoffiana</i> (Cham.) Glassman	x		x												x		x	x	x	x	x	x	x	x		x	x	x	x					x			x	
ASPARAGACEAE																																						
<i>Cordyline spectabilis</i> Kunth & Bouché																										x												
ASTERACEAE																																						
<i>Baccharis oblongifolia</i> (Ruiz & Pav.) Pers.																										x												
<i>Critonia morifolia</i> (Mill.) R.M. King & H. Rob.																										x												
<i>Gochnatia polymorpha</i> (Less.) Cabrera																																		x				
<i>Piptocarpha macropoda</i> (DC.) Baker																											x											
<i>Vernonanthura discolor</i> (Spreng.) H. Rob.																																						
<i>Vernonanthura divaricata</i> (Spreng.) H. Rob.																											x											
BIGNONIACEAE																																						
<i>Handroanthus chrysotrichus</i> (Mart. ex DC.) Mattos																																						
<i>Handroanthus serratifolius</i> (Vahl) S. Grose																											x										x	x
<i>Handroanthus umbellatus</i> (Sond.) Mattos																												x										
<i>Jacaranda bracteata</i> Bureau & K. Schum.																																						
<i>Jacaranda puberula</i> Cham.																																						
<i>Sparattosperma leucanthum</i> (Vell.) K. Schum.																																						
<i>Tabebuia cassinoides</i> (Lam.) DC.																																						
<i>Tabebuia obtusifolia</i> (Cham.) Bureau																																						
BONNETIACEAE																																						
<i>Bonnetia stricta</i> (Nees) Nees & Mart.	x		x																																			
BORAGINACEAE																																						
<i>Cordia magnoliifolia</i> Cham.																											x											
<i>Cordia sellowiana</i> Cham.																																						
BURSERACEAE																																						
<i>Protium brasiliense</i> (Spreng.) Engl.	x																																					
<i>Protium heptaphyllum</i> (Aubl.) Marchand	x																										x										x	x
<i>Protium icariba</i> (DC.) Marchand	x																																					
<i>Protium kleinii</i> Cuatrec.																																						
<i>Protium spruceanum</i> (Benth.) Engl.																																						
<i>Protium widgrenii</i> Engl.																																						
CALOPHYLLACEAE																																						
<i>Calophyllum brasiliense</i> Cambess.	x																																					





APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN													CENTRAL PLATEAU																								
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC	
CANNABACEAE																																						
<i>Celtis pubescens</i> (Kunth) Spreng.																										X											X	
<i>Trema micrantha</i> (L.) Blume													X													X												
CARDIOPTERIDACEAE																																						
<i>Citronella gongonha</i> (Mart.) R.A. Howard																																						
CELASTRACEAE																																						
<i>Maytenus dasyclada</i> Mart.																																						
<i>Maytenus gonoclada</i> Mart.																																						
<i>Maytenus ilicifolia</i> Mart. ex Reissek																																						
<i>Maytenus littoralis</i> Carv.-Okano																																						
<i>Maytenus obtusifolia</i> Mart.	X																																					
CHLORANTHACEAE																																						
<i>Hedyosmum brasiliense</i> Mart. ex Miq.																																						
CHRYSOBALANACEAE																																						
<i>Hirtella glandulosa</i> Spreng.																																						
<i>Hirtella hebeclada</i> Moric. ex DC.																																						
<i>Parinari excelsa</i> Sabine																																						
CLETHRACEAE																																						
<i>Clethra scabra</i> Pers.																																						
CLUSIACEAE																																						
<i>Clusia criuva</i> Cambess.	X	X	X																																			
<i>Clusia hilariana</i> Schltld.	X																																					
<i>Garcinia brasiliensis</i> Mart.	X	X	X																																			
<i>Garcinia gardneriana</i> (Planch. & Triana) Zappi																																						
<i>Symphonia globulifera</i> L.f.	X	X	X	X	X	X																																
<i>Tovomita fructipendula</i> (Ruiz & Pav.) Cambess.	X																																					
<i>Tovomitopsis paniculata</i> (Spreng.) Planch. & Triana																																						
COMBRETACEAE																																						
<i>Terminalia triflora</i> (Griseb.) Lillo																																						
CUNONIACEAE																																						
<i>Lamanonia ternata</i> Vell.																																						
<i>Weinmannia paulliniifolia</i> Pohl ex Ser.																																						
CYATHEACEAE																																						
<i>Alsophila sternbergii</i> (Sternb.) D.S. Conant																																						
<i>Cyathea atrovirens</i> (Langsd. & Fisch.) Domin																																						
<i>Cyathea corcovadensis</i> (Raddi) Domin																																						
<i>Cyathea delgadii</i> Sternb.																																						





APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN														CENTRAL PLATEAU																							
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC	
<i>Cyathea phalerata</i> Mart.																										x		x										
DICKSONIACEAE																																						
<i>Dicksonia sellowiana</i> Hook.																										x												
ELAEOCARPACEAE																																						
<i>Sloanea guianensis</i> (Aubl.) Benth.	x	x					x						x		x						x															x		
<i>Sloanea hirsuta</i> (Schott) Planch. ex Benth.									x																													
ERICACEAE																																						
<i>Agarista revoluta</i> (Spreng.) J.D. Hook. ex Nied.	x																																					
<i>Gaylussacia brasiliensis</i> (Spreng.) Meisn.																											x										x	
ERYTHROXYLACEAE																																						
<i>Erythroxylum citrifolium</i> A. St.-Hil.			x																																			
<i>Erythroxylum cuspidifolium</i> Mart.			x																																			
<i>Erythroxylum vacciniifolium</i> Mart.											x	x																								x	x	
EUPHORBIACEAE																																						
<i>Actinostemon klotzschii</i> (Didr.) Pax																										x												
<i>Alchornea glandulosa</i> Poepp. & Engl.			x														x											x									x	
<i>Alchornea sidifolia</i> Müll. Arg.																	x		x																			
<i>Alchornea triplinervia</i> (Spreng.) Müll. Arg.	x	x	x	x	x	x	x	x	x	x		x	x	x					x		x	x					x	x	x							x		
<i>Algernonia riedelii</i> (Müll. Arg.) G.L. Webster			x																																			
<i>Aparisthium cordatum</i> (A. Juss.) Baill.			x																																			
<i>Croton floribundus</i> Spreng.																										x		x									x	
<i>Croton organensis</i> Baill.																											x											
<i>Croton piptocalyx</i> Müll. Arg.																																					x	
<i>Croton urucurana</i> Baill.																																					x	
<i>Mabea piriri</i> Aubl.	x																																					
<i>Maprounea guianensis</i> Aubl.										x																x												
<i>Sapium glandulosum</i> (L.) Morong	x			x													x											x										
<i>Sebastiania brasiliensis</i> Spreng.																																					x	
<i>Sebastiania commersoniana</i> (Baill.) L.B. Sm. & Downs																											x											
<i>Sebastiania serrata</i> (Baill. ex Müll. Arg.) Müll. Arg.																																					x	
<i>Tetrorchidium rubrivenium</i> Poepp.																																						
FABACEAE																																						
<i>Abarema brachystachya</i> (DC.) Barneby & J.W. Grimes																																						
<i>Adenanthera pavonina</i> L. (exotic species)																																						
<i>Albizia pedicellaris</i> (DC.) L. Rico			x																																			



APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN												CENTRAL PLATEAU																										
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC		
<i>Albizia polycephala</i> (Benth.) Killip ex Record																									x														
<i>Andira anthelmia</i> (Vell.) Benth.					x												x	x	x	x	x							x											
<i>Andira fraxinifolia</i> Benth.			x	x		x	x	x	x		x	x	x	x												x				x									
<i>Andira nitida</i> Mart. ex Benth.	x	x					x	x	x																														
<i>Andira ormosioides</i> Benth.				x																																			
<i>Apuleia leiocarpa</i> (Vogel) J.F. Macbr.				x																																			
<i>Bauhinia longifolia</i> (Bong.) Steud.																									x														
<i>Chamaecrista ensiformis</i> (Vell.) H.S. Irwin & Barneby				x																																			
<i>Copaifera langsdorffii</i> Desf.				x																					x			x		x								x	
<i>Copaifera trapezifolia</i> Hayne				x																																			
<i>Dahlstedtia pinnata</i> (Benth.) Malme								x																															
<i>Dalbergia villosa</i> (Benth.) Benth.																									x														
<i>Erythrina crista-galli</i> L.																								x															
<i>Erythrina falcata</i> Benth.																																							
<i>Inga edulis</i> Mart.				x	x	x									x																								
<i>Inga laurina</i> (Sw.) Willd.					x																																		
<i>Inga marginata</i> Willd.																																							
<i>Inga sessilis</i> (Vell.) Mart.	x	x	x																																				
<i>Inga striata</i> Benth.																																							
<i>Inga subnuda</i> Salzm. ex Benth.												x																											
<i>Inga thibaudiana</i> DC.				x																																			
<i>Inga vera</i> Willd.																																							
<i>Inga vulpina</i> Mart. ex Benth.																																							
<i>Lonchocarpus cultratus</i> (Vell.) A.M.G. Azevedo & H.C. Lima				x		x																																	
<i>Machaerium aculeatum</i> Raddi																																							
<i>Machaerium acutifolium</i> Vogel																																							
<i>Machaerium brasiliense</i> Vogel																																							
<i>Machaerium hirtum</i> (Vell.) Stellfeld																																							
<i>Machaerium lanceolatum</i> (Vell.) J.F. Macbr.																																							
<i>Machaerium nyctitans</i> (Vell.) Benth.																																							
<i>Machaerium stipitatum</i> Vogel																																							
<i>Machaerium uncinatum</i> (Vell.) Benth.				x																																			
<i>Machaerium villosum</i> Vogel																																							
<i>Mimosa bimucronata</i> (DC.) Kuntze																																							
<i>Myroxylon peruiferum</i> L.f.																																							
<i>Ormosia arborea</i> (Vell.) Harms	x	x	x	x																																			









APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN														CENTRAL PLATEAU																									
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC			
<i>Luehea divaricata</i> Mart. & Zucc.																								X																
<i>Pseudobombax grandiflorum</i> (Cav.) A. Robyns	X	X	X	X	X								X			X				X							X												X	
MELASTOMATACEAE																																								
<i>Clidemia capitellata</i> (Bonpl.) D. Don											X																													
<i>Henriettea saldanhaei</i> Cogn.																																								
<i>Henriettea succosa</i> (Aubl.) DC.																																								
<i>Miconia argyrophylla</i> DC.																																								
<i>Miconia chamissois</i> Naudin																																								
<i>Miconia chartacea</i> Triana																																								
<i>Miconia cinerascens</i> Miq.																																								
<i>Miconia cinnamomifolia</i> (DC.) Naudin	X	X	X	X																																				
<i>Miconia cubatanensis</i> Hoehne											X																													
<i>Miconia cuspidata</i> Naudin																																								
<i>Miconia dodecandra</i> Cogn.																																								
<i>Miconia elegans</i> Cogn.																																								
<i>Miconia fasciculata</i> Gardner																																								
<i>Miconia hirtella</i> Cogn.																																								
<i>Miconia latecrenata</i> (DC.) Naudin											X																													
<i>Miconia ligustroides</i> (DC.) Naudin																																								
<i>Miconia nervosa</i> (Sm.) Triana																																								
<i>Miconia pepericarpa</i> DC.																																								
<i>Miconia prasina</i> (Sw.) DC.																																								
<i>Miconia pusilliflora</i> (DC.) Naudin																																								
<i>Miconia pyrifolia</i> Naudin													X																											
<i>Miconia sellowiana</i> Naudin																																								
<i>Miconia theizans</i> (Bonpl.) Cogn.																																								
<i>Miconia tristis</i> Spring																																								
<i>Tibouchina estrellensis</i> (Raddi) Cogn.																																								
<i>Tibouchina granulosa</i> (Desr.) Cogn.																																								
<i>Tibouchina pulchra</i> Cogn.																																	</							

MELIACEAE

<i>Cabralea canjerana</i> (Vell.) Mart.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN														CENTRAL PLATEAU																						
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC
<i>Trichilia casaretti</i> C. DC.	x			x																																x	
<i>Trichilia catigua</i> A. Juss.																									x												
<i>Trichilia clauseni</i> C. DC.																										x										x	
<i>Trichilia emarginata</i> (Turcz.) C. DC.																																					
<i>Trichilia martiana</i> C. DC.							x																														
<i>Trichilia pallens</i> C. DC.																																					
<i>Trichilia pallida</i> Sw.																																					
<i>Trichilia silvatica</i> C. DC.																																					
MONIMIACEAE																																					
<i>Macropelplus ligustrinus</i> (Tul.) Perkins																																					
<i>Mollinedia oligantha</i> Perkins									x																												
<i>Mollinedia schottiana</i> (Spreng.) Perkins									x																												
<i>Mollinedia uleana</i> Perkins																																					
<i>Mollinedia widgrenii</i> A. DC.																																					
MORACEAE																																					
<i>Brosimum gaudichaudii</i> Trécul																																					
<i>Brosimum guianense</i> (Aubl.) Huber							x																														
<i>Ficus adhatodifolia</i> Schott ex Spreng.																																					
<i>Ficus citrifolia</i> Mill.																																					
<i>Ficus clusifolia</i> Schott	x																																				
<i>Ficus enormis</i> Mart. ex Miq.																																					
<i>Ficus gomelleira</i> Kunth	x																																				
<i>Ficus guaranitica</i> Chodat																																					
<i>Ficus hirsuta</i> Schott																																					
<i>Ficus insipida</i> Willd.																																					
<i>Ficus luschnathiana</i> (Miq.) Miq.																																					
<i>Ficus obtusiuscula</i> (Miq.) Miq.																																					
<i>Ficus organensis</i> (Miq.) Miq.	x																																				
<i>Ficus pulchella</i> Schott	x																																				
<i>Maclura tinctoria</i> (L.) D. Don ex Steud.																																					
<i>Pseudolmedia laevigata</i> Trécul																																					
<i>Sorocea bonplandii</i> (Baill.) W.C. Burger <i>et al.</i>																																					
MYRISTICACEAE																																					
<i>Virola sebifera</i> Aubl.																																					
<i>Virola urbaniana</i> Warb.																																					

MYRTACEAE																																					
<i>Blepharocalyx salicifolius</i> (Kunth) O. Berg	x																																				







APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN											CENTRAL PLATEAU																										
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC	
<i>Marlierea silvatica</i> (O. Berg) Kiaersk.						x																																
<i>Marlierea tomentosa</i> Cambess.												x	x		x	x			x	x																		
<i>Myrceugenia glaucescens</i> (Cambess.) D. Legrand & Kausel																																					x	
<i>Myrceugenia ovata</i> (Hook. & Arn.) O. Berg																										x												
<i>Myrcia anacardiifolia</i> Gardner																										x												
<i>Myrcia anceps</i> (Spring) O. Berg				x																																		
<i>Myrcia bergiana</i> O. Berg	x																																					
<i>Myrcia brasiliensis</i> Kiaersk.												x	x	x							x																	
<i>Myrcia dichrophylla</i> D. Legrand														x																								
<i>Myrcia glabra</i> (O. Berg) D. Legrand													x								x																	
<i>Myrcia guianensis</i> (Aubl.) DC.														x																								
<i>Myrcia hartwegiana</i> (O. Berg) Kiaersk.							x																													x		
<i>Myrcia hebeptala</i> DC.																										x												
<i>Myrcia hexasticha</i> Kiaersk.						x																																
<i>Myrcia ilheosensis</i> Kiaersk.	x	x	x		x		x		x		x	x																										
<i>Myrcia insularis</i> Gardner												x	x	x				x																				
<i>Myrcia laruotteana</i> Cambess.																											x	x	x						x	x		
<i>Myrcia multiflora</i> (Lam.) DC.	x	x	x		x			x	x		x	x		x	x		x	x	x	x	x	x																
<i>Myrcia palustris</i> DC.											x	x								x																		
<i>Myrcia pubipetala</i> Miq.								x				x	x	x							x																	
<i>Myrcia pulchra</i> (O. Berg) Kiaersk.									x		x																											
<i>Myrcia racemosa</i> (O. Berg) Kiaersk.	x		x	x	x		x	x	x		x	x	x	x																								
<i>Myrcia recurvata</i> O. Berg	x																																					
<i>Myrcia selloi</i> (Spreng.) N. Silveira																												x										
<i>Myrcia splendens</i> (Sw.) DC.								x																		x	x	x						x	x			
<i>Myrcia tomentosa</i> (Aubl.) DC.																																						
<i>Myrcia venulosa</i> DC.																																						
<i>Myrcia vittoriana</i> Kiaersk.	x																																					
<i>Myrcianthes gigantea</i> (D. Legrand) D. Legrand																										x												
<i>Myrciaria delicatula</i> (DC.) O. Berg																																						
<i>Myrciaria floribunda</i> (H. West ex Willd.) O. Berg			x																							x												
<i>Myrciaria tenella</i> (DC.) O. Berg																																						
<i>Neomitranthes glomerata</i> (D. Legrand) D. Legrand												x																										
<i>Neomitranthes warmingiana</i> (Kiaersk.) Mattos														x																								
<i>Pimenta pseudocaryophyllus</i> (Gomes) Landrum											x																											
<i>Psidium cattleianum</i> Sabine	x	x					x		x		x	x	x	x	x	x	x	x	x	x	x	x	x															



APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN													CENTRAL PLATEAU																							
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC
<i>Siphoneugena densiflora</i> O. Berg											x			x												x		x									x
<i>Siphoneugena guilfoyleana</i> Proença												x																									
<i>Siphoneugena kuhlmannii</i> Mattos																										x											
<i>Syzygium jambos</i> (L.) Alston					x		x																		x				x								
(exotic species)																																					
NYCTAGINACEAE																																					
<i>Guapira nitida</i> (Mart. ex J.A. Schmidt) Lundell				x	x		x																														
<i>Guapira opposita</i> (Vell.) Reitz	x	x	x	x	x		x		x			x								x	x	x	x			x	x	x									
<i>Pisonia ambigua</i> Heimerl																										x											
OCHNACEAE																																					
<i>Ouratea castaneifolia</i> (DC.) Engl.																																					
<i>Ouratea parviflora</i> (A. DC.) Baill.																																					
<i>Ouratea semiserrata</i> (Mart. & Nees) Engl.																										x											
OLACACEAE																																					
<i>Heisteria perianthomega</i> (Vell.) Sleumer				x																																	
<i>Heisteria silvianii</i> Schwacke							x						x													x											
<i>Ximenia americana</i> L.																																				x	
OLEACEAE																																					
<i>Chionanthus filiformis</i> (Vell.) P.S. Green													x		x																						
<i>Chionanthus micranthus</i> (Mart.) Lozano & Fuertes																											x										
<i>Chionanthus trichotomus</i> (Vell.) P.S. Green																																				x	
PENTAPHYLACACEAE																																					
<i>Ternstroemia brasiliensis</i> Cambess.			x						x	x	x	x														x											
PERACEAE																																					
<i>Chaetocarpus myrsinites</i> Baill.			x																																		
<i>Pera glabrata</i> (Schott) Poepp. ex Baill.	x	x	x	x	x		x	x	x		x	x	x	x					x		x	x			x	x	x	x							x		
PHYLLANTHACEAE																																					
<i>Hieronyma alchorneoides</i> Allemão				x									x															x	x							x	
<i>Hieronyma oblonga</i> (Tul.) Müll. Arg.	x			x																																	
<i>Margaritaria nobilis</i> L.f.				x																																	
<i>Richeria grandis</i> Vahl																																					
<i>Savia dictyocarpa</i> Müll. Arg.																									x										x		
PIPERACEAE																																					
<i>Piper amalago</i> L.																																					
<i>Piper arboreum</i> Aubl.							x																													x	
<i>Piper cernuum</i> Vell.																																					
<i>Piper crassinervium</i> Kunth																																				x	









APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN														CENTRAL PLATEAU																								
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC		
<i>Xylosma glaberrimum</i> Sleumer											x															x													
<i>Xylosma prockia</i> (Turcz.) Turcz.																										x													
<i>Xylosma tweedianum</i> (Clos) Eichler																																					x		
SAPINDACEAE																																							
<i>Allophylus edulis</i> (A. St.-Hil. et al.) Hieron. ex Niederl.																																							
<i>Allophylus petiolulatus</i> Radlk.																																							
<i>Cupania emarginata</i> Cambess.	x		x																																				
<i>Cupania oblongifolia</i> Mart.																																							
<i>Cupania racemosa</i> (Vell.) Radlk.																																							
<i>Cupania vernalis</i> Cambess.																																							
<i>Matayba elaeagnoides</i> Radlk.																																							
<i>Matayba guianensis</i> Aubl.	x		x									x	x	x																									
<i>Matayba juglandifolia</i> (Cambess.) Radlk.																																							
SAPOTACEAE																																							
<i>Chrysophyllum flexuosum</i> Mart.																																							
<i>Chrysophyllum gonocarpum</i> (Mart. & Eichler ex Miq.) Engl.																																					x		
<i>Chrysophyllum inornatum</i> Mart.																																							
<i>Chrysophyllum marginatum</i> (Hook. & Arn.) Radlk.																																					x		
<i>Ecclinusa ramiflora</i> Mart.																																							
<i>Manilkara subsericea</i> (Mart.) Dubard	x																																						
<i>Pouteria beaurepairei</i> (Glaz. & Raunk.) Baehni																																							
<i>Pouteria caimito</i> (Ruiz & Pav.) Radlk.	x																																				x		
<i>Pouteria torta</i> (Mart.) Radlk.																																							
<i>Sarcaulus brasiliensis</i> (A. DC.) Eyma																																							
<i>Sideroxylon obtusifolium</i> (Roem. & Schult.) T.D. Penn.																																							
SIMAROUBACEAE																																							
<i>Simarouba amara</i> Aubl.	x																																						
SIPARUNACEAE																																							
<i>Siparuna guianensis</i> Aubl.																																							
SOLANACEAE																																							
<i>Aureliana fasciculata</i> (Vell.) Sendtn.	x																																						
<i>Cestrum axillare</i> Vell.																																					x		
<i>Cestrum schlechtendalii</i> G. Don																																					x		
<i>Solanum bullatum</i> Vell.																																					x		
<i>Solanum caavurana</i> Vell.																																							
<i>Solanum granuloseprosum</i> Dunal																																					x		
<i>Solanum pseudoquina</i> A. St.-Hil.																																					x		



APPENDIX 1. Continued.

FAMILIES/SPECIES/SITES	COASTAL PLAIN													CENTRAL PLATEAU																									
	JU1	JU2	JU3	PA1	PA2	PA3	IAN	BER	CE1	CE2	ICA	IM1	IM2	IM3	PST	BAT	CAB	ATA	ALE	GT1	GT2	TOR	LPE	TAI	UBE	COQ	SRC	CRP	CA1	CA2	BR1	BR2	ITA	AGU	RCL	BRA	SUC		
<i>Solanum sanctae-catharinae</i> Dunal																						x					x												
STYRACACEAE																																							
<i>Styrax acuminatus</i> Pohl																																				x			
<i>Styrax camporum</i> Pohl																											x									x			
<i>Styrax glabratus</i> Schott									x																														
<i>Styrax leprosus</i> Hook. & Arn.																																							
<i>Styrax pohlii</i> A. DC.																																							
SYMPLOCACEAE																																							
<i>Symplocos estrellensis</i> Casar.																																							
<i>Symplocos nitens</i> (Pohl) Benth.																																							
<i>Symplocos nitidiflora</i> Brand																																							
<i>Symplocos pubescens</i> Klotzsch ex Benth.																																							
<i>Symplocos tenuifolia</i> Brand																																							
<i>Symplocos uniflora</i> (Pohl) Benth.																																							
THEACEAE																																							
<i>Laplacea fruticosa</i> (Schrad.) Kobuski	x		x						x																														
THYMELAEACEAE																																							
<i>Daphnopsis fasciculata</i> (Meisn.) Nevling																																							
<i>Daphnopsis racemosa</i> Griseb.																																							
URTICACEAE																																							
<i>Boehmeria caudata</i> Sw.																																							
<i>Cecropia glaziovii</i> Sneath.																																							
<i>Cecropia lyratiloba</i> Miq.																																							
<i>Cecropia pachystachya</i> Trécul																																							
<i>Coussapoa microcarpa</i> (Schott) Rizzini																																							
<i>Pourouma guianensis</i> Aubl.																																							
VERBENACEAE																																							
<i>Citharexylum myrianthum</i> Cham.																																							
VOCHYSIACEAE																																							
<i>Qualea multiflora</i> Mart.																																							
<i>Vochysia tucanorum</i> Mart.																																							
WINTERACEAE																																							
<i>Drimys brasiliensis</i> Miers																																							